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Jet Propulsion Laboratory
Pasadena, CA

MEETING REPORT

Marc S. Allen	**Steven W. Squyres**
Executive Secretary	Chair

SPACE SCIENCE ADVISORY COMMITTEE (SScAC)
Jet Propulsion Laboratory, Pasadena, CA
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Monday, November 1

Welcome and Chair's Remarks

Dr. Steven Squyres, Chair of the SScAC, called the meeting to order and introduced Dr. Edward Stone, Director of the Jet Propulsion Laboratory (JPL), who welcomed the SScAC to JPL. He noted that the space science program is doing well from the standpoint of the Office of Management and Budget (OMB) and Congress, and there are a number of space science launches during 2001. After introductions, Dr. Squyres reviewed the agenda.

Mars Exploration Program

Mr. Scott Hubbard, the new Director of the Mars program, provided an end-to-end overview of the program. Dr. Dan McCleese, Program Scientist at JPL, led a discussion of the science drivers, and Dr. Firouz Naderi, Program Manager at JPL, discussed the technology needs and process over the next year. Mr. Hubbard noted that he had been given two assignments—fix the management issues (contributing to the Mars failures), and replan the program. He focused primarily on the latter topic at this meeting. The management team and procedures are in place to address the previous management problems. This presentation is part of Phase 3 of the planning exercise—presenting publicly the results of the first two parts and getting feedback from the advisory groups.

There are new roles and responsibilities at NASA Headquarters (Mars Program Director and Mars Program Scientist) and at the Lead Center, JPL (Mars Program Manager). There are clear lines of authority/accountability with information exchange, inclusiveness and openness to new concepts, effective risk management, and comprehensive and efficient independent reviews. The Mars program has been defined as "a science-driven, technology-enabled effort to characterize and understand Mars, including its current environment, climate and geological history, and biological potential." Over the past 6 months, the program replanning has emphasized outreach and data gathering. Science community input has been extremely helpful. An Executive Planning Team has been directing this process. During the synthesis phase, retreats were conducted with the Mars community. In response to a question, Mr. Hubbard noted that the three options were primarily budget driven and bracket the possibilities from in-budget to significantly out of the budget range. Outside expertise was brought in to assist with cost estimating; independent insight was obtained from the Independent Program Analysis Office (IPAO) at the Langley Research Center (LaRC) and the Science Applications International Corporation (SAIC). The Mars Program Independent Assessment Team (MPIAT) felt that the program had made an excellent response to its recommendations on management and that the 2001-2005 and out-year planning looked good. The MPIAT made a series of recommendations for the 2003 mission.

The program is derived from science, technology, and management strategies. The science strategy is to meet the priorities set by the community through a phased process (seeking, in-situ observation, and sampling). The technological strategy is to develop the key technologies before they are included into the program (phasing them in through precursor missions). The management strategy is to make a priority commitment to safety and mission success and continue the emphasis on program-level systems engineering (putting all the constraints into a trade space to optimize the science return on the dollar). The program must be resilient to mission failures, discoveries/surprises, and to any schedule slips of international elements. One of the themes at all of the meetings was the intersection of space science goals and human exploration goals. Many investigations are of interest to both groups. The management strategy provides program resilience through two alternating launch series—a sequence of landed science/sample return and a sequence of orbiters, both on 4-year centers, interleaved with each other. Discovery-like missions should fill in gaps left by the missions in this dual-series approach. Mr. Hubbard described the process used in determining the mission queues. The only real constraints are the budget, physics, and scientific/technological readiness. The budgeted elements include: an orbiter in 2001, twin Athena rovers in 2003, a reconnaissance orbiter in 2005, and a competed Scout mission. The new science payloads on the 2005 orbiter will be fully competed. The future proposed program architecture includes: a

competed Scout mission and netlanders in 2007; long-range in-situ science (lander/rover) in 2009, a possible telecommunications orbiter from the Italian Space Agency (ASI) in 2007, an ASI/NASA science orbiter in 2009, and an orbiter and the first part of sample return in 2011. One of the questions that would be useful to get advisory committee input on is: To what extent should NASA be fully open or more focused on the Scout Announcements of Opportunity (AO's)? Beyond 2011, the program becomes much more conceptual—perhaps another French Space Agency (CNES) sample return and science orbiter and a U.S. sample return and in-situ science lander/rover.

Mr. Hubbard discussed the "budgeted" option which pushes the sample return mission to 2013. A second, "accelerated" architecture has two sample returns in 2011 and would require significant augmentation. He focused on a third, "middle" (moderate augmentation) option. The CNES wants to participate with an orbiter and netlanders in 2007; it would be a technology demonstration of aerocapture. Having provided the technology, there would be a sample return in 2011 as well as a Scout payload. ASI is willing to provide a dedicated telecom orbiter in 2007. The Mars program is scientifically rich, publicly exciting, and meets the constraints. Combining the strategies will address Mars' biological potential. Mr. Hubbard noted that everything beyond 2005 should be considered a "living document." Sample return dominates the trade space and discussion and is still considered a consensus high priority by the community; however, a substantial investment is required. The total mission cost for Mars Sample Return (MSR) is on the order of $2 billion: $700 million to develop the Mars Ascent Vehicle (MAV); $350 million for the Orbiter (most provided by the French); $250 million for technology; and about $300 million for sample handling and curation.

Mr. Hubbard discussed the elements beyond the current queue, including the 2005 Mars Reconnaissance Orbiter (MRO), which includes high-resolution imaging; high-resolution spectroscopy; and recovery of science from the lost Mars Climate Observer (MCO) mission. There are two ends of the spectrum—no additional money and a generous augmentation. If there is no addition funding, NASA can still do the missions in 2001, 2003, and 2005, plus the Scout mission in 2007; beyond that, things start to slip out and Mars Sample Return could be as late as 2014. If there is another $2 billion over the next 12 years, there could be two sample returns launched by the beginning of the next decade (2011 or even 2009 with a more aggressive budget profile—i.e., $1 billion in 2005). Currently, there is not a plan for this more aggressive profile. Over the next year, the program will reduce the uncertainties in estimates for 2007 and beyond by an intensive "program systems engineering" activity.

In response to a question, Mr. Hubbard indicated that none of the groups felt that there was a realistic option without sample return, though experts in in situ investigation believe that with the huge advance in sensors, there will be extremely enhanced capability for this type of investigation. There is a parallel path for developing in situ investigation. Both samples and in situ investigation are needed. The issue of sample handling must be addressed now, and a team has been designated to develop a set of definitions, requirements, etc., for the Agency. Notional budgets have been put together. There will be a whole range of activities working on this. At this point, there has been enough conservatism in the estimates that the job can probably be done.

Dr. McCleese discussed the science assessment of the program and the science traceability of the new plan. He showed the prioritized science objectives within each goal: life, climate, geology, and preparation for human exploration. The challenge is to explain this and tie it all together. A group of workshops have been ongoing since last fall and have looked at the framework for addressing Mars. The science community is interested in an achievable program, and every group has agreed that this architecture is achievable. There is controversy over how quickly the program should have sample return, and the launch date of sample return dictates the program. Dr. McCleese showed how the goals link. One of the threads is water. There is a phased strategy for answering the questions—seek (orbital and airborne reconnaissance to provide the foundation); in situ (in situ experiments and reconnaissance to provide ground-truth); and sample (Mars sample returns for testing hypotheses). A lot of thought went into this strategy.

Dr. Naderi discussed the technology coupling and the roll-out of the MRO. Technologies will be introduced in precursor missions. Beyond 2005, the next mission is a "smart lander." Dr. Naderi discussed the desired feature of the next generation of landers: ability to land precisely, ability to detect and avoid

hazards, a prudent level of hazard tolerance, long range mobility, and long life. A key technology is entry, descent, and landing (EDL), particularly guided entry for precision landing. A smart lander would have guided entry and hazard avoidance for landing. The plan is for an evolution in landers. The 2003 rovers would have about 23 kg of payload. The 2005 rover would have the capability to go almost a mile; the 2007 rover would be capable of carrying a 300 kg payload and would be able to go the distance from Los Angeles to San Diego. To engage the public, the rovers and Scouts need a good telecom relay. A dedicated orbiter for telecom would provide a fair number of hours at a wide range of latitude. The CNES orbiter is looking at aerocapture and in-orbit rendezvous. In addition, the program is trying to find a way for the surface craft to survive the launch of the ascent vehicle and do additional science for 2 or 3 years.

Discussion
Dr. Squyres noted two things that he would like to get out of the committee discussion: (1) a response to the content and the structure of the program before it hardens; and (2) advice on how to implement some aspects of the program, e.g., how to spend "seed" money on Scout missions. He asked for individual member comments on the Mars program and the plan.

Dr. Drake summarized the view of the SSES, which was briefed on the program earlier in the week. The "A" Team has been put on the program and has worked very hard. The SSES strongly supported the results of Mr. Hubbard's team and the plan. However, Dr. Drake noted that he personally felt that the program does not feed into the probable "what's next" question regarding human exploration of Mars. The robotic missions may not phase in to a much larger national endeavor for human exploration.

Dr. Papike felt that this plan is too timid, flawed, unbalanced, and not focused on the science issues after 2005. Early sample return is needed for ground truth and it cannot be obtained sufficiently with in situ. He felt that the program needs an early "no frills" sample return in 2007, e.g., a smart lander with a drill and scoop and MAV (a technology mission to test elements). He stated that he thought that 2009 is the latest you should bring a sample back and still have a balanced program.

Dr. Richstone observed that the real question is: What is the role of the sample return? It is very obvious that every gram is tremendously expensive. Is this really necessary? Will in situ not satisfy objectives? Dr. Squyres noted that there was unanimity in the Mars community regarding the importance of sample return. Dr. Drake added that there must be measurements of adequate precision and accuracy; currently, these types of measurements cannot be made in situ and this drives the position of the community.

Dr. Farmer noted that in the Mars Exploration Program Analysis Group (MEPAG) deliberations, many felt that we are still learning about Mars. An early and costly grab sample from one spot on the planet will probably not provide adequate ground truth. Sophisticated in situ investigations may provide information regarding mineralogy of the surface. The current program allows for technology development at a better pace. A lot of the sites of highest interest are outside the constraints of the air bag landing system. Is there a way that the engineering community can solve the landing problem with a hybrid landing system? Dr. Naderi noted that there are approaches that could open up the latitude accessibility. Some of the factors are the energy available and direct entry versus drop off from orbit.

Dr. Zuber indicated that the planning done over the last six months demonstrates a tremendous amount of thought. The right people are on the job to make it happen. The crucial issue is to make sure we have a sustainable Mars program; the out years are fairly conservative, but they probably need to be that way right now. There are a lot of "tall poles" in sample return, but it must be a part of the program. The precursor missions are addressing the technological poles in a systematic way. Doing a quick sample return is a bad idea because the odds of failure would be high. We need to get some successes before a more aggressive approach can emerge.

Dr. Das was favorably impressed with the program. There is sufficient overlap between this program and commercial technology activities and DOD interests. There is considerable joint interest in many of the technologies. Precursor missions are a good idea, and there could be joint, collaborative projects. Regarding sample return, one needs to have caution but 2013 would be a long time to wait. We should be able to do something at a faster pace.

Dr. Mewaldt was pleased with the program; he shared the concern about the risk involved in advancing the program and doing a sample return more quickly. He posed the question: How does the risk of the different timetables compare? Mr. Hubbard noted that to move MSR to 2009 and still have technology demonstrations means you only have 14 months between the landing of 2007 and the launch of 2009; this is not enough time to react to surprises. If 2007 had a serious problem, a large amount of cost would already be spent and 2009 would have to be fixed. You could ameliorate this somewhat by having a very large budget for redundancy (like Viking), but that is currently not in the plan.

Dr. Hawkins noted the large public appeal. MSR will have a great public impact; perhaps an earlier sample return could be presented as a technology demonstration. The current program outreach seems to be heavily focused on the public. There should be an opportunity to make a greater impact in the classroom, e.g., there should be more emphasis on K-12. There must be a coordination framework for the Scout missions; particular areas of emphasis could be specified in the AO.

In response to a question by Dr. Farmer, Mr. Hubbard clarified the Discovery aspects of the program. The idea is that 15 to 20 concepts could be funded, leading to an AO in 2002. The same idea would be applied to 2011.

Dr. Margon was concerned about the proposed timeline for sample return in 2013 and its programmatic impact to OSS. He thought that the public support for sample return would be extremely high, but this plan will consume resources for decades to get back to where Viking was 30 years ago.

Dr. Dressler noted that the community has been very bad at predicting what the public is really interested in. It is not a "given" that a single sample return will energize people; however, it will raise expectations of something completely revolutionary about Mars. We do better to bring the public along in an orderly program.

Dr. Squyres indicated that he was firmly in agreement with Dr. Papike regarding the scientific importance of sample return. However, many technological "miracles" need to take place for successful sample return. The program that was presented does a good job of validating the technologies needed to get samples back. Apollo was structured to validate technology and techniques step-by-step. Mars opportunities occur on 26 month centers. Celestial mechanics coupled with a need to do technology on a timeline that works drives the schedule. There is consensus on community-generated, openly competed missions interspersed into the program. They provide an opportunity to respond to discoveries and allow a broad array of science outside of the mainline of the program. Dr. Squyres noted that there would be further discussion on the Mars program later in the meeting.

Science Theme Director Reports

Dr. Jim Spann reported on the Sun Earth Connection (SEC) theme. He discussed some of the SEC successes and provided a status report on some of the missions. One of the public outreach successes was the "Bastille Day" event—a coronal mass ejection (CME) and x-ray flare. The aurora went down into Texas and Florida, and the event made national news. Another big success was the Transition Region and Coronal Explorer (TRACE)—a Small Explorer that looks at the Sun in the Far Ultraviolet (UV). TRACE images made the front page of the New York Times. These two examples provide good groundwork and support for Living With a Star (LWS), which is in the FY 2001 budget. The goal is to develop the scientific understanding necessary to effectively address those aspects of the connected Sun-Earth activity and how it affects society. LWS will provide support for space weather and will provide information for global climate change. It will include targeted data analysis and modeling, space environment testbeds, and partnerships with DOD, the National Oceanographic and Atmospheric Administration (NOAA), and the National Science Foundation (NSF). There are a series of notional missions that are looking at the Sun and heliosphere—the Solar Dynamics Observatory (SDO) and solar sentinels. There is also a geospace dynamics network. LWS will be working with the Human Exploration and Development of Space (HEDS) Enterprise to characterize the environment for human space flight. A science architecture team has been put together to assess the overall LWS system. Cluster-2 has been launched and is in the process of checkout and commissioning. The Imager for Magnetospheric to Aurora Global Exploration (IMAGE) has

provided images of the proton aurora; this will help scientists understand the dynamics of storms in the magnetosphere. SEC is going through a good phase with missions operating well and others coming on line. LWS is a major initiative for the theme. Dr. Squyres noted that the SScAC was very pleased that LWS was approved.

Dr. Bergstralh reported on the Solar System Exploration (SSE) theme. The Near Earth Asteroid Rendezvous (NEAR) has provided close-up (6km) images of Eros with 1-1/2 meter resolution; what is interesting is the softness of the craters, indicating some type of space weathering. Mars Global Surveyor (MGS) is about to complete its prime mission and has been approved for its extended mission. There are two SSE experiments on a Japanese mission (Nozomi) to Mars. Deep Space 1(DS-1) has an extended mission to Comet Borelly. Stardust will encounter Wildt 2 in January 2004, and will return a sample in January 2006. The camera malfunction will not affect the sample return. Genesis will launch in 2001 to collect samples of the solar wind. Comet Nucleus Tour (CONTOUR) will launch in 2002 and do two comet fly-bys. The U.S. has experiments or pieces of experiments on two ESA missions—Rosetta and Mars Express. Messenger is a Discovery mission to Mercury, to be launched in 2004. Deep Impact is a Discovery mission to Comet Tempel 1 to study the interior properties of the comet. Large ground-based telescopes will support the flight instruments. Over the next ten years, SSE will have a large set of missions in their prime data-taking modes. This is leading to a new paradigm on how to support the planetary scientific community. With the large set of missions, it makes more sense to expand data analysis, i.e. broaden the planetary data analysis program. Dr. Squyres observed that this change represents a major paradigm shift for the planetary community and is very healthy.

Outer Planets Reformulation Status

Dr. Bergstralh reviewed the status of the Outer Planets program. At the last SScAC meeting, the Outer Planets program consisted of three missions: Europa Orbiter in 2004, Pluto/Kuiper Express (PKE) in 2006, and Solar Probe in 2008. The Outer Planets program has had a number of technical challenges and is being significantly rethought. The serious technical and programmatic issues include: launch vehicle selection and availability for flight; radioisotope power source development schedule and cost; and budget profile and overall cost estimates (which have increased by a factor of 2). The radioisotope power source development (controlled by DOE) has not been successful as planned and will not be an available technology for the 2006-2007 timeframe. Another technology (more efficient than the traditional one) is being carried as an option. Conventional radioisotope thermal generators (RTG's) are also being carried as options: F-5 (a fueled element of an RTG, surplus from Galileo); E-8 (an unfueled RTG from Cassini); and E-9 (a potential RTG that could be assembled). Two RTG's would use up the entire domestic civilian supply of plutonium 238. It is not currently being produced in the U.S, although there is a contract open with the Russians for another year. Europa Orbiter would need two RTGs; Pluto would need one. Dr. Drake noted that there is a somewhat "fluid wall" between the civilian and defense stock of plutonium that could be explored. Plutonium 238 is crucial to all of the outer solar system exploration missions as well as the long-term Mars program. Solar Probe has been taken out of the Outer Planets program and is a part of the new LWS initiative, and SEC has asked for a study of a non-nuclear powered version of Solar Probe. With respect to launch vehicles, the masses of all of the spacecraft have grown to the point that they can no longer be launched on Delta II's; the current desired baseline is Delta IV for no Earth gravity assist. It would take a Delta IV-heavy for Europa Orbiter and one of the lesser Delta IV's for PKE. The larger launch vehicles are much more expensive; this is the single largest cost growth element. The other issue is that the Delta IV does not have the required number of successful launches (14) between now and 2004 to ensure reliability. Use of the Shuttle Inertial Upper Stage (IUS) is a more complicated story, but involves the issue of nuclear devices on the Shuttle. The baseline approach does not include an Earth gravity assist. There are some other options that involve Venus gravity assists that would address some of the launch vehicle problems. With respect to budget, the baseline program needs $150 million per year. Another problem is the budget profile—it is end-loaded and does not support the program timeline. All of the technical and programmatic issues have led to a stop work order to JPL for PKE. PKE was singled out for stop work order due to clear guidance from the Administration (OMB) that Europa Orbiter is the "must do" mission in the program, i.e., if Europa Orbiter is not part of the Outer Planets program, there is no program. Part of the science concern is that as Pluto retreats from perihelion, there is some evidence that its atmosphere may collapse. However, there is not unanimity in the planetary community regarding this

issue. Another science issue for Pluto is geometry—it has high obliquity; as time elapses, more of the planet moves into polar darkness.

An Outer Solar System Senior Science Team was established to recommend a restructuring of the program—to articulate a coherent framework of goals and objectives for exploration of the outer solar system and to identify investigations that clearly contribute to achieving them. There was some valid criticism from the National Academy of Sciences (NAS) that the SSE roadmap was not scientifically coherent. Mission lines should not be used as an administrative umbrella for a set of unrelated missions. There was no interaction between the Team and the SSES until the SSES meeting on October 30-31. The Team is about halfway through its effort. Goals and objectives have been identified, and they are more fully articulated than in previous versions. The overall driver was to produce something coherent that has traceability flowing from goals to objectives to investigations. The document was distributed to the SSES on October 31, and suggestions and criticisms have been invited. The document will also be sent to the NAS Committee on Planetary Exploration (COMPLEX) for review/comments. The priority of Europa Orbiter is a constraint from above; whether it has to happen first is open to interpretation. If launching PKE first imperils Europa Orbiter, it is a "nonstarter" for the program. The Headquarters Senior Science Team will consider the known milestones, the entry of Huygens into Titan and the Europa Orbiter prime mission. Decisions regarding funding availability and the resultant launch sequence will be delayed until the replanning effort is complete.

Discussion
Dr. Drake reported on the SSES findings. The Outer Planets program problem is very difficult. Dr. Drake met with OMB (Mr. Steve Isakowitz) last spring. Mars and Europa got healthy because of the "life" theme. You have to do Europa, but you don't necessarily have to do Europa first. There is not enough money to do either Europa or PKE in a sensible timeframe. The fundamental problems are: there is not a coherent set of missions, the program is paralyzed by the budget profile and there has been a "raid" on the program dollars, and there are strong drivers for doing Pluto first. If Pluto is launched first and Europa got to its destination first, there could still be a viable program. OMB wants to see the Europa science; launch dates are less important than getting the science return. The SSES will formally recommend that the program be competed across the board—i.e., a Request for Quote (RFQ) on a very fast timeline (Feb/Mar) leading to studies over the summer with an answer by the end of the summer. There could be innovative thinking from several groups. This will be the last chance to save the program; we will not have a program with a single mission. We need to change the way we are thinking about Europa. Dr. Squyres noted that the SScAC would return to the Outer Planets discussion on the following day.

Lunch Talks – Advanced Rover Development and Future In Situ Instruments for Mars Exploration

During lunch, Dr. Eric Baumgartner discussed Advanced Rover development at JPL and showed some of the technology. He discussed some of the things that make robotic systems on other planets difficult and explained the evolution of capabilities from first generation rovers (through 2003), 2nd generation rovers (2005-2007) and 3rd generation rovers (2009 and beyond). One of the critical areas is mobility—how to get around on the surface of the planet. Other issues are rover localization (keeping track of where you are), rover navigation (reactive hazard detection and path planning), instrument placement, and autonomous operation (including fault detection and recovery). Dr. Baumgartner described the FIDO rover—a mobile platform for science and technology demonstration for the 2003 mission. JPL has built a prototype of FIDO that had its first blind trial of mission operations last May. The primary mission was exploration and discovery using the rover; it also had an education and outreach component. The rover continually evolves and is fed by the technology program at JPL. Two technology paths have been looking at reconfigurable robotics. Another technology task this year was cooperative robotics—coordinated transport of a PV tent container by two robots and transport of an extended object requiring closely coupled coordination of multiple robots.

Dr. Paula Grunthaner discussed a subset of the in situ instruments for Mars that have relevance for life detection—a chemical imaging probe and an atomic force technique. Dr. Grunthaner showed examples of topographic imaging taken with the chemical imaging probe. The atomic force technique is used for topographic imaging and spectroscopy. It can be used to scan a sample and get topography information at

the nanometer scale. Another instrument gives laser induced fluorescence and raman spectroscopy. This instrument will be tested this year. Yet another instrument will allow determination of amino acids and chirality (a possible probe for extinct or extant life in extraterrestrial environments). The premier instrument for life detection is nuclear magnetic resonancing (NMR)—there is a candidate prototype NMR in the lab.

Science Theme Director Reports

Dr. Alan Bunner reported on the Structure and Evolution of the Universe (SEU) theme, starting with missions in operation. The Extreme Ultraviolet Explorer (EUVE) will operate through the end of the calendar year using a stretch-out of existing funds. The Rossi X-ray Timing Explorer (RXTE)/Solar Maximum Mission (SMM) earned top marks in the recent Senior Review. Chandra is doing well and has had several recent press stories, including the supernova gamma ray burst observed a month ago. The last round of proposal selections yielded oversubscription on the observing time by a factor of 6.2. The High Energy Transient Explorer (HETE)-2 launched successfully on October 9 and is going through checkout. Gravity Probe B (GP-B) is accomplishing its milestones but the slow progress has left a $72 million shortfall. The Gamma Ray Large Area Space Telescope (GLAST) has a possible 6-month delay, as a result of fallout from GP-B. Constellation-X is proceeding and there has been good news on the quantum calorimeter. NASA has offered a flight opportunity to ESA for a Laser Interferometer Space Antenna (LISA) Test Package on Space Technology 3 (ST-3). There are two opportunities for the technology demonstration. A draft AO for the science payload for the Advanced Cosmic-ray Composition Experiment on the Space Station (ACCESS) will be posted in late November. The Cosmic Journeys initiative is in the budget process for FY02. Five new missions associated with the SEU theme have been selected in the Explorer program. The Microwave Anisotropy Probe (MAP) passed the Red Team review, but the launch date has slipped to June/July 2001. The GALEX cost overrun has been reviewed and fixed. The Cosmic Hot Interstellar Plasma Spectrometer (CHIPS) has some cost problems related to additional reviews.

The New Biological and Physical Research Enterprise

Dr. Squyres noted the significant reorganization at NASA Headquarters that resulted in the creation of a fifth Enterprise—the Office of Biological and Physical Research (OBPR). The SScAC was particularly interested in understanding the relationship between OSS and the new Enterprise. Dr. Kathie Olsen, NASA's Chief Scientist, connected to the SScAC meeting via telecon. She noted that the Administrator has a biology vision for NASA. We need to recognize the importance of biology for the advancement of fundamental knowledge and the advancement of technology. Mr. Goldin's vision is to create a virtual, interdisciplinary program at NASA focused on biology, to bring together physics, chemistry, biology, and engineering to foster interdisciplinary research. The fundamental science questions are addressed in NASA's Strategic Plan; biology plays into these at all levels. The questions require fundamental and applied research for answers. Dr. Olsen emphasized that biology is an integral part of the entire Agency and is not funneled into a single code. She compared the former Office of Life and Microgravity Sciences and Applications (OLMSA) with the new structure. The health and safety of the astronauts is so important that there is now an Office that reports directly to the Administrator; all of the nonresearch crew health aspects moved into this Code A office. Before the reorganization, biology was a small part of Code U. The critical need is to have an integrated program of research. OBPR consists of the full spectrum of research from basic through applied—of biological, physical, chemical, and biomedical research. About 80% of funds go to the university community. It also establishes the organization that will utilize the International Space Station (ISS). There are two major fundamental questions: How have the fundamental laws of nature shaped the evolution of life? How can humans expand beyond the home planet and take full advantage of space? There will be three research divisions in the new Enterprise: Bioastronautics (biomedical and human research), Physical Sciences in Space, and Space Fundamental Biology. Part of the responsibility of the deputy division directors is integration across all of the codes. The fine-tuning of the organization will come from the advisory groups. Dr. Baruch Blumberg is coming to NASA Headquarters to serve as Dr. Goldin's assistant and senior advisor. One of his major responsibilities is to set up search committees for the leadership of the new Enterprise and help to get it started in the right direction. Selections for these positions will be critical. Dr. Olsen invited input from the OSS on the role of its Commercial Space Centers (CSC's). She is looking for better coordination of the CSC's with science.

Dr. Olsen discussed the goals, organization, and enhancements in each of the Divisions. Dr. Eugene Trinh is working with Dr. Bunner to improve communications between the programs in fundamental physics. In response to a question regarding the intellectual "glue" that holds the Enterprise together, Dr. Olsen indicated that right now, this is the science that gets done on the ISS. The program hopes to evolve and look at what platforms make sense for the science and work closely with Code S and Code Y in this endeavor. Dr. Richstone noted that what Dr. Olsen is describing as "fundamental physics" is actually "laboratory physics in space." One thing that has been a problem is that fundamental physics has never had a "home" in the Agency. To the SScAC the name "physical sciences" was confusing (it means physics in the universe). Dr. Olsen noted that the Division of Fundamental Space Biology is complementary to some of the Code S activities; it will develop the biological understanding to support astrobiology activities and planetary protection. She has strongly recommended that astrobiology stay in Code S. An interagency working group will be chaired by the new astrobiology lead. Astrobiology fits in with the space science questions and is a major part of the Origins program. Dr. Olsen invited comments from SScAC on this issue. She noted that the new astrobiology NASA Research Announcement (NRA) is also sponsored by Code U and Code Y. The Division of Research Integration will work closely with Code Y and Code S, and will look at the best platforms for investigations. This Office will be the lead for ISS/Shuttle manifest planning. Biology is an integral element of Agency-wide research and technology development. Coordination of biological research across Enterprises is necessary to achieve Enterprise and Agency goals.

The SScAC members noted that the word "fundamental" has a different meaning to space scientists. Dr. Bunner indicated that he has had a lot of discussion with Dr. Trinh; their work includes study of atomic physics, and is what most physicists would call laboratory or basic physics. Dr. Olsen agreed that the word "fundamental" is confusing and should be changed to "laboratory" physics. The separate Enterprise will provide a balanced portfolio. Currently, the new Enterprise has a budget of about $300 million. Plans for funding increases have been prepared for consideration by the new Administration; however, it is up to the leadership of OBPR to make the case for augmentations.

Dr. Squyres commended the Agency for the way that the new Enterprise has been handled. It initially alarmed a lot of people, but the Agency has steered a very wise path, taking an existing code and enriching its science content and helping to support other codes in the Agency. Dr. Olsen emphasized that the key issue is the right people in the leadership positions.

Science Theme Director Report – Astronomical Search for Origins (ASO)

Dr. Anne Kinney reported on the ASO theme. The Shuttle is delaying the next Hubble Space Telescope (HST) servicing mission by 8 months resulting in increased HST costs. The Two Micron All Sky Survey (2MASS) is nearly complete and is producing interesting results. Keck is on schedule, and there is good progress in hardware development. Reallocation of funds has been made to the Stratospheric Observatory for Infrared Astronomy (SOFIA). The Space Infrared Telescope Facility (SIRTF) has had an 8-month slip largely due to Infrared Array Camera (IRAC) instrument problems. This slip is the second largest cost problem that Origins is facing. Phase A trade studies are being worked on ST-3. There are cost and schedule issues on the Space Interferometry Mission (SIM), and teams have been formed to look at serious rescopes. The science team selection is imminent, and the team will participate in this activity. Nexus (a technology precursor for the Next Generation Space Telescope) will be reviewed in the new year. The project is doing studies on what can be tested on the ground and what must be tested in orbit. Dr. Weiler has determined that Nexus objectives will be limited to technology demonstrations. The SIRTF Legacy proposals oversubscribe the observing time by a factor of about 5.6. 2MASS has discovered two new globular clusters and one new galaxy. There is continuing public interest in Origins.

Subcommittee Report on SEC

Dr. Ray Walker gave the report from the Sun-Earth Connection Advisory Subcommittee (SECAS) which met the previous week. The SECAS commended Dr. Withbroe for his leadership. LWS promises exciting new science and will help address some national concerns. The Subcommittee heard a presentation on the planned Research and Analysis (R&A) Senior Review. The SECAS was concerned that there is not adequate time between the establishment of the new cluster structure and the first assessment of the review. Also, many of the SEC missions will be going through their Senior Reviews at the same time, and running the reviews in parallel runs the risk of diluting the quality of both. The SECAS recommended that the

cross-cluster review be delayed one year until the reorganization becomes mature and concerns are appropriately addressed. Dr. Squyres noted that the Research program was on the agenda for the following day, and he deferred discussion until then. Dr. Walker noted that the other significant issue from the SECAS was low-cost access to space. The sounding rocket program is a key component of the SEC theme, and the program is in crisis. The University Explorer (UNEX) program is now indefinitely postponed. Dr. Drake noted that the SSES also was concerned about sounding rockets/attached payloads. The SECAS had several recommendations: transfer management for the sounding rocket program to the SEC Theme Director, fund the number of launches commensurate with the scientific pressure and technical training needs, make restoration of the health of the sounding rocket program a central part of the NASA/University Initiative, and conduct a system-wide evaluation of NASA's low-cost access to space to develop an overall program. With respect to LWS, the SECAS recommended that data analysis, theory, and modeling should be treated as a LWS mission with its own science definition team. The SECAS addressed Red Teams and costs. The Subcommittee was concerned with the cost growth of missions and that the levels of risk considered reasonable for each class of mission have not been well articulated. The SECAS felt that the scale of the mission should determine the level of risk. Of the two responses to address the cost growth issue, SECAS prefers reducing the science scope and maintaining the flight rate over reducing the flight rate and maintaining the science scope. Dr. Hawkins did not agree with the conclusions of the SECAS on this issue.

Government Performance and Results Act (GPRA) 2000 Performance Report

Dr. Marc Allen led the discussion on the Performance Report. OSS needs to provide a snapshot of the outcomes of science over FY00. Dr. Allen provided the report on progress on each of the 19 science objectives. He asked each member to look at the items related to their discipline and comment on the text and provide additional input, if necessary on achievements or failures. SScAC did a collective assessment of the color code for each of the objectives, based on the brief text summaries. The results were:

1. Observe the earliest structure in the Universe. BLUE
2. Observe the emergence of stars and galaxies in the very early Universe. GREEN
3. Observe the evolution of galaxies and the intergalactic medium. GREEN
4. Measure the amount and distribution of dark and luminous matter in the ancient and modern Universe. GREEN
5. Test the General Theory of Relativity. GREEN
6. Identify the origin of gamma-ray bursts and high-energy cosmic rays. GREEN
7. Study compact objects and investigate how disks and jets are formed around them. GREEN
8. Study the formation and evolution of the chemical elements and how stars evolve and interact with the interstellar medium. GREEN
9. Measure space plasma and processes both remotely and in situ. GREEN
10. Observe and characterize the formation of stars, protoplanetary disks, and planetary systems, and detect Neptune-size planets around other stars. GREEN
11. Measure solar variability and learn to predict its effect on Earth more accurately. GREEN
12. Study the interactions of planets with the solar wind. GREEN
13. Characterize the history, current environment, and resources of Mars, especially the accessibility of water. YELLOW
14. Determine the pre-biological history and biological potential of Mars and other bodies in the solar system. GREEN
15. Determine whether a liquid water ocean exists today on Europa, and seek evidence of organic or biological processes. GREEN
16. Investigate the composition, evolution, and resources of the Moon, small bodies, and Pluto-like objects across the solar system. GREEN
17. Complete the inventory and characterize a sample of near-Earth objects down to 1-km diameter. YELLOW
18. Reconstruct the conditions on the early Earth that were required for the origin of life and determine the processes that govern its evolution. GREEN
19. Investigate the processes that underlie the diversity of solar system objects. GREEN

Assignments were made to help craft the appropriate words to go with the color code assessments. Inputs are due by November 8.

Continued Discussion on the Mars Exploration Program

The SScAC had a thorough, wide-ranging discussion on the restructured Mars program. Dr. Gehrz felt that the restructured program is a good program that should be pursued. We should also try to advocate and get funds for an accelerated of sampling (different scope/more frequent). Dr. Richstone noted that it takes 2 years to get there, and it takes 2 years to bring a sample back. A sample return at any point does not impact what you are going to do for this period. Sample return involves a lot of technology, risk, and cost. If all of the funds were put into in situ devices, wouldn't this be a better choice? Dr. Squyres noted that while there are some great in situ devices, they will never do all the science that could be done in a terrestrial laboratory. Dr. Papike added that flight instruments will not come close to making the measurements required to address some of the fundamental questions. There must be a balanced program—samples, data from orbit, and in situ. In situ studies as a substitute for samples does not hold up. Dr. Kolb stated that the public interest is in science results. If we take the money that we would be spending for sample return and put it into new in situ techniques, would that be the answer? Dr. Freedman questioned whether this is too conservative a program (in response to the failures, the Young report, etc.). Has the pendulum swung too far the other way? If sample return is that important, perhaps we should be more aggressive. Dr. Drake noted that it is possible that some measurements that are currently impossible to make might come within reach of in situ measurements with improvements and breakthroughs in techniques and instrumentation. However, there will be other measurements that you will never reach, e.g., to measure every single atom in a sample and to measure relatively subtle fractionations in isotopes. Dr. Squyres noted that the Mars presentation to the SScAC lacked a really solid statement that explained to people from other disciplines the true scientific significance of sample return. He suggested that future presentations make very clear the importance of samples. Dr. Mewaldt stated that samples are not only the ground-truth but make it exciting to a lot of people. It takes a long time because it is a tough problem; it takes time to develop technology and test it. A rushed sample return has a high danger of failure and should not be done. Dr. Dressler indicated that he though that the program was a balanced one; it came from the community and sounds well reasoned. Dr. Hawkins did not agree with putting all of the sample money into in situ investigations. It is not a good trade. It would be short-sighted of NASA to compromise something that has a very high potential. Dr. Farmer observed that everyone in the Mars community realizes the value of a return sample. However, in the case of Mars, we are dealing with a heterogenous body; a grab sample might not tell us anything about history or local geology. The concept of ground-truth is less meaningful than it would be on the Moon. A deliberate approach to sample return is appropriate. The program is cost constrained and technology constrained; risk needs to be mitigated. Getting initial ground-truth from in situ observations at a number of spots makes sense. To invest three or four opportunities to get a sample return that is not well-targeted is not wise in the current cost and technology environment. The deliberate program that was presented makes a lot of sense. Dr. Drake added that part of the disagreement on early versus late sample return involves the likelihood of finding evidence of life.

Dr. Squyres noted that the SScAC generally agreed that sample return should be included in the Mars program, although some of the members felt that the rationale was not clearly articulated in the presentation. Most of the lack of consensus was on how aggressively to pursue sample return. Dr. Squyres summarized the three things that the SScAC agreed upon: the management structure and organization is vastly superior to what went before; the concept of Discovery-class missions funded within the Mars line is an excellent idea (the SSES should give NASA advice on how to best craft the AOs.); and the Mars 2005 mission needs a science definition team (SDT) fairly soon.

Dr. McCleese noted that there is a group that is capturing the science requirements in terms of measurements that have to be made. He showed how sample return is essential to understanding Mars and the science goals and objectives. We want to know whether life might have existed. Understanding chronology is essential. Radiometric age determination is not possible except with a sample. In addition, correlative, simultaneous ways of making measurements are crucial, and this is one of the fundamental things that a sample gives you.

In summary, Dr. Squyres highlighted some points: the SSES was broadly supportive of the new Mars program that Mr. Hubbard laid out; there is and has been a broad consensus that sample return is crucial to the Mars Exploration program, and Code S needs to do a good job of making that case; the big issue is how rapidly we move to sample return. Sample return requires about half a dozen significant technological breakthroughs in order for it to take place with a high reliability of success. The SScAC felt that NASA should go forward with the program that seeks to accomplish these breakthroughs as quickly as possible, recognizing that with the funding constraints, it cannot take place as rapidly as would be desired. The general structure of the program is a good one. In order to move more aggressively than the "middle" program that was presented by Mr. Hubbard, there must be significant funding augmentation. NASA should pursue getting this funding. Mr. Hubbard noted that with support from OMB and Congress, significant funding augmentation, and the right budgetary profile, one of the two sample return missions could possibly move to 2009; however, it would be impossible to move it to 2007. Mr. Hubbard noted that he is continuing to cast a wide net for innovative approaches. There is a big trade space for sample return, and the program is continuing to look at that trade space. Dr. Hawkins emphasized the importance of public outreach and education for the Mars program and suggested that it be put out for competition.

Thursday, November 2

Dr. Squyres started the meeting with a brief recap of the discussions of the previous day. With respect to the Office of Biological and Physical Research (OBPR), the SScAC was pleased that there was no encroachment of elements within the purview of Code S and was pleased to see the strong science focus in the new Enterprise. The SScAC gained a solid understanding of the RTG and launch issues, as well as the OMB priorities on the Outer Planets program; however, the Committee did not see a clear solution. On the Mars program, the SScAC was very pleased with the new management structure and the Discovery-like missions that are now part of the program. The Committee will recommend that science definition teams for the 2005 missions and perhaps even the 2007 missions be formed as soon as possible. Most of the discussion centered on sample return and how aggressively NASA should be moving toward it. The key points were: the SSES was strongly supportive of the program; the science is well-organized and is traceable to long-standing science objectives; the structure is good; and in the planetary community, sample return is crucial. However, those not closely connected with the program did not clearly see how sample return is crucial to understanding Mars. When the new program gets presented to broader audiences, the traceability to the need for sample return needs to be explicit. The biggest issue was how rapidly NASA should move to sample return. There are four or five "miracles" that have to take place. One of the real strengths of the program is that it includes demonstrations and precursors to move forward in a measured way. The SScAC would like to move toward sample return as quickly as feasible consistent with an appropriate level of risk. Dr. Weiler indicated that over the long term, he would like the SScAC to address how more funding augmentations to the Mars program fit in with other things in OSS, i.e., the balance issue.

OSS Status Report and Discussion

Dr. Weiler showed some HST movies of very dynamic stellar objects with planetary disks. Chandra is entering its prime mission phase and is starting to get some good headlines, e.g., a missing link black hole. NEAR has provided some very high-resolution images of Eros. Dr. Weiler reviewed the major NASA space science launches in CY 2001 and 2002 and other significant events in 2001. He noted that the launch rate starts to go up again in 2001. There are a number of missions in development that are in "yellow" and "red" status. HST is yellow because the Shuttle manifest has slipped the mission. Funds to pay for the slip come directly out of the Next Generation Space Telescope (NGST), resulting in that mission being red. Also, there is a growing requirement for a flight test of the optical system (Nexus), and there is a debate on whether this is necessary. An independent review will be done and a decision on Nexus will be made in February. The SIRTF project has schedule and cost problems due to the IRAC instrument. SOFIA is overrunning, and there will be a launch slip to December 2002. Space Technology 3 (ST-3) and Space Interferometry Mission (SIM) are red because they are coming in at much higher costs than originally estimated. OSS will be looking at these very carefully. JPL has been given a runout cost cap for SIM. The Keck interferometer is also overrunning and will slip. Cassini is yellow because of problems with the Huygens probe. Rosetta is red because of overruns on the U.S. instrument. A decision was made to cancel the U.S. rover for the Mu Space Engineering Satellite (MUSES); NASA will still provide Deep Space

Network (DSN) time and will get something in return (to be negotiated). Europa Orbiter and Pluto are red because of excessive growth in runout costs. Genesis is having major budget problems. Dr. Weiler noted that a number of the major missions obtained support during a very upbeat era. The Tom Young committee results have had two effects—one was positive: having the right reserves, doing the right level of analysis and testing, etc.; the negative effect was that it can be used to mask previous engineering optimism. The third factor causing the increase in costs has been increases in mass, requiring larger launch vehicles. The Discovery and Explorer programs have not seen significant cost increases because these programs tend not to push technology to the edge, and they go through full and open competition with independent cost reviews. In the past, this has not been done for the strategic plan missions. Starting with Mars, all missions will have an independent cost review. The Thermosphere-Ionosphere-Mesosphere Energetics and Dynamics (TIMED) mission has slipped. Solar Probe is red and has been moved out of the Outer Planets program. JPL is considering a non-nuclear power source for this mission. Program management will be at GSFC; project management will continue at JPL. The Inner Magnetospheric Explorer (IMEX) is red due to cost problems. Future UNEX money may be moved back into the rocket program. Small flight projects can be proposed as Missions of Opportunity in the Discovery and Explorer programs. Now that Living with a Star (LWS) has been approved, the next theme for a new initiative is SEU. The Far Infrared-Submillimeter Space Telescope (FIRST) is yellow; work on the telescope has been stopped and a decision on whether to continue will be made in the next 2 months. OSS is still fully committed to providing the instruments. Planck is red because of severe budget problems. GP-B is now yellow instead of red; it has been meeting all of its critical milestones and is on its cost with reserves.

Dr. Weiler discussed the termination of EUVE. In the 1998 and 2000 Senior Reviews, EUVE received low scores and was recommended both times for termination at the end of CY 2000 after completing its calibration measurements with Chandra. This was because of the low potential for new science discoveries and fact that the research proposed was not as compelling as other missions operating during the same time frame. Dr. Squyres noted that the EUVE decision and some other decisions in the planetary area have caused unwarranted consternation in the community. These were perceived as problems due to a lack of communication between NASA Headquarters and the community. He posed the question: What can SScAC do to help with this problem? Dr. Weiler gave an action to Dr. Allen to ensure that there are biweekly telecons with the SScAC and Subcommittee Chairs (the SScAC Executive Council). Dr. Squyres noted that the SScAC has considered preparing two letters after each of its meetings: the usual letter to Dr. Weiler and an Executive Summary of the letter for community-wide distribution (using email, Web pages, etc.). Dr. Hawkins suggested having an executive summary with a convenient link to the longer letter from Dr. Squyres. Dr. Allen took an action to work on this issue. Dr. Weiler agreed that OSS has to do a better job of getting the facts out to the community.

There is a crisis in the Outer Planets program, and it must be restructured. The current budget profile for the program far exceeds the maximum available budget. Even with slipping Europa Orbiter to 2007 and launching a Pluto mission in 2004, there still would not be enough money. Over $300 million has already been spent on technology. The Pluto mission was scheduled to ramp up to $1 million per week beginning October 2000. The only reason OMB and the Administration created the Outer Planets program was Europa; therefore, there was no choice other than to stop work on Pluto. A team has been formed to formulate a viable plan for Outer Planets exploration that is responsive to the Outer Planets roadmap. It must include sufficient budget and reserves for each mission, adequate data analysis, necessary facility support, acceptable launch vehicles, technology funding for follow-on missions, and formulation phase funding for follow-on missions. The funding profile must be consistent with the FY 2001 budget runout of $1.2 billion for Outer Planets. OSS does not want to lose this line. Dr. Colleen Hartman, reporting to the Deputy Associate Administrator, will chair the team's executive committee; the proposed plan will be formulated by the JPL Outer Planets team led by Dr. Doug Stetson. A restructured plan must be presented to Headquarters in December. Dr. Squyres noted that the SScAC is pleased that OSS is putting a serious focus on the problem.

Dr. Weiler showed the space science budget history from 1995 through the current budget request (2001). He noted that OSS is implementing the concept of a long-term data analysis program for Mars; the same is possible for Outer Planets. There is significant new content in the FY 2001 budget: LWS, the Mars program, future activities in solar system, Discovery micromissions, the New Millennium Program (NMP),

and astrobiology instrument technology. In LWS, there is an embedded R&A increase. The astrobiology instrument technology program supports the Mars program (including instrumentation on the ground to handle samples); this will be fully competed and peer-reviewed. Dr. Weiler reviewed the FY 2001 earmarks assigned to OSS (total of $39.5 million, net of $26.5 million). He noted that the controversial comments on Research and Data Analysis (R&DA) in the initial House language for the FY 01 VA-HUD Appropriations Act were deleted in conference committee. The approved budget includes an R&A increase of 3% every year, starting in 2002. Dr. Weiler reviewed the SScAC recommendations from the last meeting. He noted that the National Astrobiology Research Laboratory (NARL) and the NASA University Initiative topics were on the agenda for later in the day. OSS will increase the cost cap for Discovery and Explorer missions to accommodate the need for increased risk analysis and reserves. One of the most positive reactions from Congress is in response to what OSS is doing for education. OSS has led NASA in getting great educational material out to teachers. OSS products are now tied into the one-stop-shopping place at the Department of Education. A demonstration of the system was on the agenda for later in the day. With respect to the mission cost estimate increases, OSS is getting a more accurate picture from GSFC and JPL on the cost and risk of missions. OSS has an opportunity to have healthier programs in Outer Planets, interferometry, and NGST. The community needs to help OSS with ideas on the Outer Planets program.

Subcommittee Reports

Dr. Drake reported on the SSES meeting on October 30-31. The SSES concluded that the Mars program is in good shape with a much-improved management structure. The only disagreement was over the pace of the program; however, there are practical limits on how fast the program can be driven. At their meeting, the SSES spent a full day on Outer Planets. It is not clear that even Europa can be done, much less Europa and Pluto. The consensus was that you need to go back to the drawing board. One of the proposals was to issue a very fast RFQ program, completely open, and throw the entire Outer Planets program open to innovative ideas. The proposals would have to have a preliminary scrub on costs. If there are any viable proposals, NASA could go forward with some study money (in January/February) and make a final "go-no go" decision next summer. Dr. Squyres noted that this sounds like a good idea, but that Dr. Drake should run this by people in the procurement process. The SSES is recommending going down this path, but will not include recommendations on the implementation details of the process. OSS needs to decide if the implementation is doable. The basic idea is to wipe the slate clean, cast a wide net, move fast. Dr. Weiler indicated that the process needs to lead to a procurement fairly quickly. The SSES is looking hard at whether the orbital mechanics can be worked to start Pluto first and still get to Europa first. If you cannot meet the 2004 launch opportunity for Pluto, then the mission needs to be rethought; however, this should be examined one more time. Dr. Drake noted that there is a real problem with balance between inner planets and outer planets. There is also an issue of breadth. The planetary program is in serious danger of going to a program that only includes Mars and Europa; much of the program is driven by the origins paradigm. A new paradigm needs to be developed, e.g., the "frontier," to explain why we are exploring the solar system. There is a problem with how we deal with Venus. A question from Dr. Stofan concerns why and how we look at Venus—how it evolved differently from Earth or in the concept of the processes of building planets. This group will look carefully at the motivation for going forward with a Venus mission. The SSES also discussed Cassini/Huygens—it is not an unfixable problem, and a solution is achievable. Dr. Weiler noted that one option is to do the Cassini mission as planned, and do Huygens at the end of the mission. The Deep Space Network (DSN) is heading into a fairly serious crisis—a 200% capacity demand in the next few years. There will be problems getting data back. Dr. Weiler noted that there is a yearly meeting with his international counterparts, and this was one of the key issues. Mr. Squibb is looking into this. The SSES discussed the suborbital and attached payloads program. The planetary program has not paid enough attention to these platforms. Suborbital needs some attention. The Planetary Data System has a fairly small problem ($1-2 million) to get data out in a form that the community can use. A small amount of money could make a big difference to accessibility of data. With respect to MUSES-CN, it is important to make an arrangement with the Japanese so that U.S. scientists get access to the samples. This needs to be negotiated.

Dr. Margon reported on the SEUS, which met September 25-26. The three major projects in the Cosmic Journeys initiative scored very well in the Decadal Survey. LISA and Constellation-X are desperately in need of technology funds. Dr. Weiler noted that he and Dr. Bunner have been working vigorously to get a

new line for SEU. The SEUS had the same issue (balance of expertise and a simple algorithm) as the SSES with respect to the R&A Senior Review. There was concern that it couldn't work. The SEUS was sufficiently concerned that it felt it needed to review and comment on the draft "proposals" prepared by the drafting team. The SEUS was concerned that U.S. participation in FIRST (the telescope) is in jeopardy. This could reduce the scientific influence/return to the U.S. community. Dr. Bunner noted that he would work on this issue with ESA. With respect to LISA, NASA has created a flight opportunity, but U.S. participation is unfunded. FY01 technology funds would be needed to meet the schedule. The SEUS liked the AO for cross-cutting technology funds and would like to see more of it. The Agency is ramping up to close to $1 billion in technology money; the community needs to keep asking the question of how this is being peer-reviewed. With respect to the Explorer flight rate, the SEUS felt that risk reduction on Explorers should be proportional to the scope and cost of the mission. In terms of the Small Explorer (SMEX) selections, selection of Joule reaffirms the science case for very high resolution X-ray spectroscopy. An opportunity for recovery from the Astro-E catastrophe might be present. Dr. Weiler noted that he will not make a selection before its time. A very ambitious DOE astrophysics satellite (Supernova Acceleration Project) is in pre-proposal stage; cost studies are underway. The science is at the front-line, cutting edge. Future NASA participation might be possible. Dr. Margon noted that he provided this item to SScAC for information purposes. Dr. Squyres asked him to keep an eye on this project for the SScAC. Dr. Weiler noted that he has very clear priorities from the NAS; if DOE wants to propose a collaboration, it would have to go through competition, i.e., the Explorer program.

Dr. Dressler discussed some recent findings from HST (determination of the radius and age of a gas giant planet around HD209458) that showed a nice synergism between HST and ground based telescopes. There are origins-theme Discovery-class missions now being proposed that are within the capabilities of technologies at the present time. Dr. Dressler reported on the Origins Subcommittee (OS) meeting October 16-17. The OS has been concerned that the exploration of extra-solar planets rests on two very expensive missions far in the future. There are some planetary search missions that can be done under Discovery. Dr. Weiler emphasized that the Discovery AO is not just to visit objects in the solar system; it also includes the search for extra-solar planets and looking at other solar systems. The SScAC was pleased that there can be a suite of Origins missions that could fit into Discovery-class. The OS heard a long presentation on SIM; the OS felt that it is vital to assess whether a less ambitious mission will still have a compelling science case. The OS felt that the science that can be accomplished at the present technology level is still important. SIM is seen as a technical and scientific precursor to Terrestrial Planet Finder (TPF). It is a crucial Origins mission. The SIM team must achieve the proper balance of capability and technological readiness to permit its development and successful flight in this decade. The OS had a presentation on the Planet Finder program and endorsed it. The OS was pleased to see that there is a process in place to review Nexus. The question of "block grants" was raised with Dr. Riegler who indicated that this is on his agenda, and he will report back to the OS at the next meeting.

Enterprise Program Balance

Dr. Allen provided some background/historical information on scientific balance. The Space Studies Board (SSB) review of the Draft 2000 Strategic Plan stated that the plan needed a more explicit discussion of OSS strategy for achieving balance between flight missions and supporting ground-based research. The SSB subsequently added that OSS needed a process to integrate senior review decisions and to look across the program strategically. OSS responded that the Enterprise would ask SScAC whether there should be a change in the OSS balance between mission development, R&A, and DA. Dr. Squyres noted that the budget trends presented by Dr. Weiler show the R&DA increasing by a substantial amount over the next 5 years.

Dr. Riegler addressed the life cycle of space science missions, R&DA, and the NASA University Initiative. The three components of the space science life cycle are research, flight missions, and data analysis. The easiest access for universities is in the observing and data analysis programs. OSS has processes in place for assessing balance within each of the three components: the balance among missions is done through the strategic planning process; for R&A, a triennial review process has been started; and within Mission Operations and Data Analysis (MO&DA), comparative reviews are used. OSS does not have a process for "cross-component" rebalancing. A white paper was prepared on this topic and only four responses were received. Dr. Riegler stated that the SScAC is the best group to make the balance assessment.

For the first time in many years, there will be an inflation increase to all R&A programs. Preparations are being made for the first-ever comparative review across the R&A program. Dr. Riegler showed the schedule for the two Senior Reviews in FY 2001—the R&A review and the SEC MO&DA review. OSS is changing the character of DA programs for planetary science missions. OSS will retain the principle of the preselected Principal Investigators (PI's) who are involved with a mission throughout its life-cycle; and it will add larger, openly accessible, openly competed DA programs. These programs should serve as a readily accessible entry point for graduate students and post-docs. They will be in addition to the R&A programs and will not replace R&A programs or deflect R&A funds. Dr. Riegler showed the history of award sizes for R&A and DA from 1990 through 2000. Options for raising the award sizes for R&A and DA are: raise the average award sizes by about 3% per year; increase average award sizes by about 10% per year (this will result in fewer awards); or re-introduce the "group grants" concept (a fraction of the cluster budget to be set aside for larger group grants). Dr. Riegler invited recommendations from SScAC on what makes the most sense.

The NASA University Initiative is part of a wider, government initiative to enhance interactions with universities. The three concepts forwarded from OSS were: to have advanced technology rotators (a more proactive technology exchange among NASA Headquarters, Field Centers, and universities); to use training grants for first- and second-year graduate students in space science; and to boost the research infrastructure at universities. Gen. Armstrong liked these ideas and expanded them for all science Enterprises.

Dr. Squyres noted three items for discussion:

1. R&A Senior Review.
2. Award size of group grants.
3. Balance among R&A, DA, and flight projects.

Discussion on R&A Senior Review
SECAS's recommendation was to postpone it 1 year. SEUS was concerned about some of the details of implementation; it felt that more than one algorithm should be used to populate the panels. OS was reasonably comfortable with the cluster review. SSES did not discuss the topic. The question that the SScAC addressed was: Should OSS deviate in any way from its current plans? In general, the SScAC supported the concept and felt that the R&A Senior Review should go forward on something close to the original schedule. However, Dr. Riegler should work with the Subcommittee chairs to find a compatible timeline. Panel members must be broad in their outlook. OSS should not be specific or put limits on the amount up for redistribution.

Discussion on Award Sizes
SScAC felt that award sizes should not be dictated. The award size should be commensurate with the maximum return on science, as determined by peer review. The quality of the proposal should dictate the funding level. The SScAC felt that there should be direction to the community and the review panels that awards should maximize science return on the dollar.

Discussion on Balance Among R&A, DA, and Flight Projects
Dr. Squyres suggested that the SScAC restrict the conversation to the balance between R&A plus DA and flight projects. Does there need to be a process by which the balance of funds between R&A plus DA versus flight projects gets assessed? It has been a long-held position of SScAC that science should not be "raided" to fix problems on a mission. What SScAC is seeing in the R&DA projection is very encouraging—the significant projected growth will help with the balance issue. Based on the positive trend, the SScAC did not feel that a review at this time is warranted; however, this topic should be looked at on a regular basis. If the positive trends do not materialize, the question of a process to balance the funds should be revisited, and some type of review should be considered. The SScAC did not recommend a change in the balance based upon the projected positive trend.

Education/Public Outreach (EPO)

Dr. Jeffrey Rosendahl provided an update on the EPO activities and some examples of the things that are going on across OSS. In 4 years, OSS has gone from a plan to a major, ongoing national program with education embedded in every mission. The funding level is $25 million per year and growing. OSS is in the process of assembling an annual report (to be released in January). OSS EPO is taking advantage of the earmarks (to create long-standing assets). In response to a question, Dr. Hawkins indicated that OSS works very closely with NASA's Office of Education; the two work together through common projects. Scientific expertise resides in OSS. OSS has focused heavily on science museums and planetariums and has funded some very high-profile things over the past year. OSS is getting a lot of outside investments, e.g., a PBS series, an HST exhibit at the Maryland Science Center, etc. A major evaluation activity has been started.

Dr. Nancy Leon has started a program based on the NMP—The Space Place outreach program. The program has a series of interlinked activities and uses a number of diverse media. It delivers high quality products in a highly leveraged infrastructure. The infrastructure consists of alliances. The products are articles (print and electronical), hands-on activities, and museum displays. Pointers in all of the products lead back to the Space Place web site. A particular effort has been made to target underrepresented groups. The Space Place also works with the Boys and Girls Clubs of America and the YWCA. The Space Place web site was created and written for young children. Dr. Leon showed the OSS projects on the Space Place web site. Because the infrastructure is already in place, it is well-suited for smaller projects and PI investigations or instruments. Space Place is expanding connections with zoos and aquariums.

Dr. Hawkins discussed and demonstrated the Space Science Education Resource Directory that was released on October 2, 2000. The directory addresses the need for easy access to space science education resources. It is a "one-stop access" web-based searchable database for educators to find high-quality space science education resources. It provides a way for prospective proposers to see what is already in the program and helps to prevent duplication of effort and fill in the gaps. The SEC and Origins Education Forums created a system that builds upon nationwide on-line database efforts. It automatically posts new products on the Department of Education system. The database can be accessed through several gateways. Over 1000 educators informed the development of the Directory. The first release of the database includes the "cream of the crop"—validated by the OSS theme Education Forums. It includes websites and electronically accessible lesson plans and activities. Specific feedback on the Directory will be obtained from teachers at national conferences. A working group has been established to address further population of the directory, independent review for science content and pedagogy, and distribution of hardcopy or physical resources. The only "gatekeeper" is scientific validity.

Dr. Rosendahl noted that some major adjustments are being made in the NRA's. He suggested that in about a year, OSS will suggest that the SScAC might want to consider a task force to have a "sanity check" on the program.

Astrobiology Task Force

At the last meeting, the SScAC felt that it did not see a compelling reason for an NARL; such a laboratory would require an augmentation to the program. If there was a laboratory, it should be competed. However, the Committee was concerned that the process that had been followed had been incomplete and rushed, and the Task Force and the SScAC did not have the opportunity to fully consider the issue. In particular, there had been no opportunity to interact with the advocates from the Ames Research Center (ARC). The Task Force was charged to go back to ARC and hear in detail from the advocates on what could be done with an NARL.

Dr. Charles Beichman reviewed the Task Force charter and the members. The group reflects a broad range of astrobiology science. The Task Force addressed four areas: the role of astrobiology in Code S, the NARL, the National Astrobiology Institute (NAI), and the role of astrobiology in the Mars program. Input on the need for an NARL-like facility was solicited from NAI PI's. The final SDT documents were distributed; there were presentations and discussions on the integrated Laboratory for Advanced Scientific Research (LASR) and other presentations by some SDT participants. The SDT felt strongly that any funding for an NARL should not derive from the other areas of space science. Proposed illustrative uses of

the facility were: Mars sample return testbed and detection of life; an environmental simulation facility; and advanced computation. The Task Force felt that a fuller discussion was worthwhile. While there were some meritorious scientific projects that could be considered for inclusion in an expanded, peer-reviewed exobiology grants program, the Task Force strongly felt that none of the proposed research topics was compelling enough or would serve a large enough segment of the astrobiology community to warrant the large capital investment (a fraction of $17 million per year for 2 years) and steady state operations costs (fraction of $12 million per year in FY 2004 and beyond) of a central facility. The NAI PI's expressed little or no enthusiasm for a centralized laboratory. Dr. Weiler noted that there is an NRA on the street for astrobiology instrumentation.

The Task Force asked several questions relative to the NAI—the scope and quality of research, the effectiveness of the NAI in creating a community, the effectiveness of the NAI as a virtual enterprise, how much value is added to the grants program, the effectiveness of the executive council, etc. These questions were also sent to the NAI PI's a couple of months prior to the meeting. The NAI was asked to provide some specific metrics, e.g., the number of direct publications, NAI participation in mission planning, outreach effectiveness, cybertools, etc. The Task Force commended NASA for establishing the NAI as a fundamental component of an exciting new field. While NAI is still starting up, there is already excellent science being carried out. There is a broad range of disciplines, a strong Web-based outreach program well integrated into Origins, and good leveraging of external resources. There have been some start up problems. Some of the virtual communication tools are rather "klunky." The executive council needs to be used more effectively for science guidance and strategic planning. The major concern was about the NAI Director running the NAI from NASA Headquarters. There is a need for a strong scientific leadership at "NAI Central." Dr. Blumberg noted that his plan was to go to Headquarters and start the senior advisor position, realizing that it may be temporary depending on the change in Administration. For the immediate future, he can hold both positions. NASA Headquarters is considering a "visiting committee" to examine the NAI and to make recommendations before renewal of the NAI.

With respect to the astrobiology program, the Task Force felt that astrobiology is an important part of the intellectual life of OSS with vital short and long-term links to OSS missions. There has been a strong response to the NAI Cooperative Agreement Notice (CAN), suggesting burgeoning interest in astrobiology. While the NAI should grow to about 15 teams ($20 million per year), further growth should be assessed relative to the needs of the overall program, including the grants program and technology. There was support for expanding the peer-reviewed grants program by $5-$10 million per year. In response to a question, Dr. Beichman noted that there were some members of the Task Force who felt that the ratio of NAI funds to grants money (2:1) is becoming a matter of concern. The Task Force was pleased with the initiation of the new technology program for instrument development. It urged NASA to support activities to investigate life in extreme terrestrial environments in collaboration with other agencies.

Dr. Beichman indicated that the Task Force would be preparing a written report for Dr. Kinney.

Discussion
Dr. Squyres noted two items for SScAC endorsement: (1) the Task Force was very positive with respect to the NAI and (2) the Task Force strongly believes that as a long term solution, it is not viable for one person to function both as Director of the NAI and senior advisor to the Administrator in Washington. With respect to the NARL, the matter was better researched and investigated by the Task Force, and the conclusions have not changed. In response to a question, Dr. Morrison noted that the LASR will be a signature building in a new research park, and ARC will go forward with it, independent of the decision on a centralized NARL. Dr. Squyres noted that the process has done a real service by highlighting the gap in laboratory research. The Task Force felt that it would be much more useful to have instrumentation in a number of different places (distributed) than in a large, centralized laboratory. The SScAC was in agreement with the Task Force conclusions, and felt that the process was thorough and complete. It confirmed its previous position.

The final discussion topic of the day was the Outer Planets program. Dr. Richstone noted that there are four problems: schedule, budget, plutonium, and launch vehicles. Currently, there is no architecture for the Outer Planets program. There needs to be an architecture review, similar to what went on for the Mars

program, and it needs to get underway as soon as possible. Under the circumstances, the plan that the SSES proposed made some sense. Dr. Weiler noted that JPL has been charged to come back by Thanksgiving with their best plan for Europa and Pluto. There are some basic problems with RFP's—they are traditionally issued by Centers and some organizations, e.g., APL, cannot respond. If competition is being considered, the AO is the right mechanism. If action started today and it was high priority, an AO could be released around January and a selection could be made in summer 2001. Dr. Weiler was very positive that JPL has its best people working on innovative ideas to be delivered by the end of November. He emphasized that a lot of work is going on to look at solutions and options. Dr. Squyres noted that the SScAC is not in a position to prejudge the on-going process and determine what the answer should be. The SScAC continued to strongly support Europa Orbiter and PKE as the two highest priority items for the Outer Planets program. There are key scientific objectives to be met in both projects. The SScAC was pleased that OSS is going after this problem in a rapid, aggressive fashion to get a plan in a couple of months.

Friday, November 3, 2000

General Discussion on Recommendations

The SScAC discussed the draft recommendations on the following topics: the new Enterprise (Office of Biological and Physical Research); the Astrobiology Task Force report; the Outer Planets program; the Mars program; and the OSS Research program. Final recommendations are included in Dr. Squyres' letter in Appendix D. In addition, Dr. Squyres noted that the SScAC was very pleased with the good news on the budget. The SScAC applauded OSS on the great strides in EPO.

The next meeting of the SScAC will be January 30-February 1, 2001. This meeting is tentative, depending on the events that transpire after the Presidential election. The regular spring meeting will be March 20-22, 2001, at NASA Headquarters; the summer meeting will be July 30-August 1, 2001.

The meeting adjourned at 10:30 a.m.

Revised 10/27/00

AGENDA

Space Science Advisory Committee
Jet Propulsion Laboratory
Building 180, Room 101
November 1-3, 2000

Wednesday, November 1

8:30	Welcome and Chair's Remarks	Squyres
8:45	Mars Exploration Program	Hubbard
10:15	Science Theme Director Reports (15 minutes each)	
	- Sun-Earth Connection	Spann
	- Solar System Exploration	Bergstralh
10:45	Outer Planets Reformulation Status	Bergstralh
Noon	Lunch Talks	
	- Advanced Rover Development	Baumgartner
	- Future In Situ Instruments for Mars Exploration	Grunthaner
1:00	Science Theme Director Reports (15 minutes each)	
	- Structure and Evolution of the Universe	Bunner
	- Astronomical Search for Origins	Kinney
1:30	Biological and Physical Research Enterprise	Olsen
2:30	GPRA 2000 Performance Report Discussion	Squyres
3:30	Break	
3:45	Subcommittee Report: Sun-Earth Connection	Walker
4:00	General Discussion	
5:30	Adjourn	
7:00	Committee Dinner at Mi Piace, 25 East Colorado Blvd, Pasadena	

Thursday, November 2

8:30	Welcome (report Monday activities to Ed Weiler)	Squyres
9:00	OSS Status Report and Discussion	Weiler
10:00	Break	
10:15	Subcommittee Reports	
	- Solar System Exploration	Drake
	- Structure and Evolution of the Universe	Margon
	- Astronomical Search for Origins	Dressler
Noon	Lunch	
1:00	Enterprise Program Balance	Allen & Riegler
1:45	Other Research Program Issues	Riegler
2:15	EPO	Rosendhal
3:15	Break	
3:30	Astrobiology Task Force Report on Astrobiology Laboratory Issues	Beichman
4:30	General Discussion	
5:30	Adjourn	

Friday, November 3

8:30	General Discussion and Letter Writing	Squyres
Noon	Adjourn	

SPACE SCIENCE ADVISORY COMMITTEE
Membership List

Dr. Steven W. Squyres (Chair)
Cornell University

Dr. Alok Das
AFRL/VSC

Dr. Alan M. Dressler
Carnegie Observatories

Dr. Wendy L. Freedman
Carnegie Observatories

Dr. David H. Hathaway
NASA/Marshall Space Flight Center

Dr. Edward W. Kolb
Fermi National Accelerator Laboratory

Dr. Bruce H. Margon
University of Washington

Dr. James J. Papike
University of New Mexico

Dr. William Smith
Association of Universities for Research in Astronomy

Dr. David L. Akin
University of Maryland

Dr. Michael J. Drake
University of Arizona

Dr. Jack D. Farmer
Arizona State University

Dr. Robert D. Gehrz
University of Minnesota

Dr. Isabel Hawkins
University of California, Berkeley

Dr. Molley K. Macauley
Resources for the Future

Professor Richard A. Mewaldt
California Institute of Technology

Dr. Douglas O. Richstone
University of Michigan

Dr. Maria T. Zuber
Massachusetts Institute of Technology
Cambridge, MA 02139-4307

Dr. Marc S. Allen *(Executive Secretary)*
NASA Headquarters

SPACE SCIENCE ADVISORY COMMITTEE (SScAC)
Jet Propulsion Laboratory, Pasadena, CA
November 1-3, 2000

MEETING ATTENDEES

Committee Members:

Squyres, Steven (Chair)	Cornell University
Akin, David	University of Maryland
Allen, Marc (Executive Secretary)	NASA Headquarters
Das, Alok	AFRL/VSC
Drake, Michael	University of Arizona
Dressler, Alan	Carnegie Observatories
Farmer, Jack	Arizona State University
Freedman, Wendy	Carnegie Observatories
Gehrz, Robert	University of Minnesota
Hathaway, David	NASA/MSFC
Hawkins, Isabel	University of California Berkeley
Kolb, Edward	Fermi National Accelerator Laboratory
Margon, Bruce	University of Washington
Mewaldt, Richard	California Institute of Technology
Papike, James	University of New Mexico
Richstone, Douglas	University of Michigan
Zuber, Maria	Massachusetts Institute of Technology

NASA Attendees:

Baumgartner, Eric	NASA/JPL
Bergstralh, Jay	NASA Headquarters
Blumberg, Baruch	NASA/ARC
Bunner, Alan	NASA Headquarters
Calabrese, Michael	NASA/GSFC
DeVincenze, Don	NASA/ARC
Frederick, Suzanne	NASA/JPL
Hartman, Colleen	NASA Headquarters
Hubbard, Scott	NASA Headquarters
Johnson, Torrence	NASA/JPL
Kinney, Anne	NASA Headquarters
Kniffen, Donald	NASA Headquarters
McCleese, Dan	NASA/JPL
Morrison, David	NASA/ARC
Naderi, Firouz	NASA/JPL
Norris, Marian	NASA Headquarters
Riegler, Guenter	NASA Headquarters
Rosendhal, Jeffrey	NASA Headquarters
Spann, Jim	NASA Headquarters
Stringfellow, Guy	NASA Headquarters
Terrile, Rich	NASA/JPL
Varsi, Giulio	NASA/JPL
Weiler, Ed	NASA Headquarters
White, Charles	NASA/JPL
Wood, Dan	NASA Headquarters

Other Attendees:

Bauer, David	TRW
Clark, Ben	LMA
Cruz, M.	Aerocat
Don Burroughbridge	Orbital
Goldfellow, Michael	Caltech
Lillie, Charles	TRW
McComas, Dave	Southwest Research Institute
Pollock, Randy	Orbital
Purdy, William	Ball Aerospace
Walker, Ray	UCLA

SPACE SCIENCE ADVISORY COMMITTEE (SScAC)
Jet Propulsion Laboratory, Pasadena, CA
November 1-3, 2000

FINDINGS AND RECOMMENDATIONS

Cornell University
Center for Radiophysics and Space Research

November 22, 2000

Dr. Ed Weiler
Associate Administrator for Space Science
NASA Headquarters
Washington, DC 20546

Dear Ed:

The Space Science Advisory Committee (SScAC) met at JPL on November 1-3, 2000. Our findings and recommendations from this meeting are summarized below:

Mars Exploration Program Reformulation

Scott Hubbard, Firouz Naderi, and Dan McCleese briefed us on the reformulation of the Mars Exploration Program. ***We were very impressed with the new Mars management team, as well as with the reformulated management structure***, which exhibits clear lines of responsibility for program planning and implementation.

Scott described for us the anticipated structure of the Mars program for the next several launch opportunities. It was clear that Code S has made significant progress toward establishing an achievable, science-driven, technology-enabled plan for Mars exploration. The plan is well balanced, including the desired elements of orbital reconnaissance, in situ exploration, and sample return. The near-term program (through '05) is also characterized by a level of science return and technology demonstration that is consistent with the current level of funding. Because of the rapid pace of progress required to carry out this program, the ***we recommend that a Science Definition Team be formed immediately for the 2005 Mars Reconnaissance Orbiter, and in the relatively near future for the Mars '07 opportunity.***

An aspect of the plan that we endorse with particular enthusiasm is the proposed "Mars Discovery" line of missions. These missions would be PI-led and openly competed. They would involve the broad community in the process of Mars exploration, would treat important problems with potentially broader focus than the mainline Program, and would enable the Program to adapt on a relatively short time frame to new discoveries.

We had a long discussion about the role and timing of sample return in the Mars program. Because of the challenge and cost of sample return, we urge that Mars program managers articulate clearly the unique role that returned samples would play in addressing key scientific questions at Mars. We recognize the scientific importance of sample return, and ***we recommend that the first Mars sample return occur as soon as possible, consistent with a prudent level of risk.*** We further recommend that the schedule for sample return be revisited as appropriate in the context of increased knowledge of the geological context of landing sites, potential future funding increases, and new technological developments. We endorse the approach of involving the scientific, technological and human exploration communities in future program planning.

It was also clear from what we heard that the Mars Program offers an unparalleled opportunity to engage the public and students in the adventure of exploring another planet. It is important that OSS take advantage of this opportunity to create a world-class Education and Public Outreach (EPO) effort as an integral and essential part of the program. We therefore encourage the Mars program leadership to involve leading figures from the EPO community outside and inside of NASA, and to form a broad spectrum of alliances with the EPO community.

Outer Planets Program Reformulation

We heard from Jay Bergstralh about the status of the Outer Planets Program. ***It is our conclusion that the Outer Planets Program is in a state of crisis.*** However, we also note with approval that Code S recognizes the magnitude of the crisis, and is beginning to formulate a plan to respond to it. ***We reaffirm the importance of the two highest priority scientific goals for the outer solar system defined in the strategic plan: to investigate a possible ocean on Europa and to explore Pluto and Kuiper Belt Objects.*** We urge that the essential scientific goals of these two missions not be compromised as the program is reformulated. We endorse the recommendation made by our Solar System Exploration Subcommittee that ***NASA should aggressively seek ways to recover from the present crisis by reducing the costs of the Europa and Pluto/Kuiper missions, perhaps including competing one or both missions via the AO process.***

Astrobiology

We heard from our Astrobiology Task Force (ATF), chaired by Chas Beichman. At their most recent meeting, the ATF dealt with a number of issues associated with Astrobiology. They have found that exciting work continues to be carried out under the

auspices of the NASA Astrobiology Institute (NAI), and that this growing scientific discipline has been energized by the Institute's efforts. We also heard from Chas about NAI Director Barry Blumberg's recent appointment at NASA Headquarters. We agree with Dr. Blumberg that the NAI requires a full time, in-residence Director. Therefore ***if Dr. Blumberg's current assignment to NASA HQ will last more than a few months, a search for a new NAI Director should be organized.***

In the most important part of our Astrobiology discussion, we heard a detailed report from Chas about the ATF's review of the NASA Astrobiology Research Laboratory (NARL) proposed for development at Ames Research Center. You'll recall that at our meeting in July we heard an interim report from the ATF. At that time, the ATF had met with the NARL Science Definition Team chaired by Don Lowe, but had not yet had the chance to meet with NARL advocates from Ames. While we received their interim report at that time, we directed them to hear fully and completely from the group at Ames before submitting their final recommendations to us.

We believe that ***the ATF's treatment of the NARL has now been quite thorough.*** They spent considerable time at Ames prior to our meeting discussing the NARL's goals, objectives, and organization in detail with Ames managers and scientists. They also interacted at some length with the NAI principal investigators, who brought their own very useful perspectives to the discussion.

After a careful and thorough review, the opinion of the Astrobiology Task Force and of SScAC is that there is no clear and compelling need for a centralized national Astrobiology laboratory. There is no doubt that potentially worthwhile activities could be conducted at such a laboratory. Work on topics like detection of life and prebiotic materials, environmental simulation, and computational biology are good examples. However, we feel that no compelling case has been made that a central facility is required to further these activities. Many SScAC members felt that such work could better be conducted at a number of smaller distributed facilities. We found it particularly noteworthy that it was also the overwhelming view of the NAI PIs that a centralized laboratory facility is not required.

While we recommend that the proposed NARL not be established, the dialog that this proposal has prompted has been healthy and productive. In particular, it has shown that there are exciting new areas of astrobiological science that do require significant distributed laboratory facilities. Astrobiology is a vibrant and growing field, and the absence of such facilities points to an exciting future opportunity that Astrobiology might grow into if funding increases allow.

Finally, we reiterate a point we made at our last meeting. ***Should the case for a national astrobiology laboratory ever become compelling at some point in the future, such a facility must be openly competed and selected by peer review.***

Office of Biological and Physical Research

NASA Chief Scientist Kathie Olsen joined us by telephone. She briefed us on the Agency's vision and structure for Code U, the new, fifth Enterprise, to be called the Office of Biological and Physical Research.

Now seems an appropriate time for NASA to form an enterprise focused on biological research. There is tremendous excitement today in the life sciences, drawing its intellectual impetus from the growing ability to successfully apply our understanding of physics, chemistry and complex systems to a deeper and more unified understanding of life. We understand that the purpose of Code U is to enhance NASA's participation in Biological and Physical Sciences through an office that unifies activities in several areas. NASA's unique access to extraordinary environments (for example, microgravity) gives it a special role to play, and its interest in the survival of humans in these environments gives it a major stake it some of the possible results of this research.

(For purposes of clarity, we note that what was called "fundamental physics" in Kathie's briefing would conventionally be referred to as "laboratory physics" by the Space Science community.)

We were pleased to learn that increasing coordination is planned between the science-based activities of Code U and Code S. Astrobiology has deeper and more extensive intellectual connections with the work carried out within Code S than with any other part of NASA. In order to strengthen the synergy between astrobiology and space sciences, especially the flight projects carried out by Code S, ***we agree firmly with the expressed opinion of the Chief Scientist that the Astrobiology Initiative belongs within Code S.***

Research Program

As usual, we heard a report from Guenter Riegler about the Code S research program. Guenter reported to us on several aspects of the program, including final preparations for the first-ever comparative assessment of the Code S R&A programs. We heard that all nine of the new science Clusters are now organizing working groups that will help produce Cluster Reports. These reports are to be submitted in April of 2001, for panel review in June. We recognize that there is some apprehension in the community about this new process, but ***we feel that it is important to go forward with it in order to ensure the continued vitality of the R&A Program.*** As the membership of the review panel for these reports is constituted over the next few months, we emphasize the importance of selecting individuals with a proper balance of expertise, as discussed by our subcommittees. Overall, we commend Guenter for his progress towards carrying out these reviews. Because of some minor schedule concerns in some themes, we encourage him to work with SScAC subcommittee chairs to achieve a review schedule that is satisfactory for all.

We were also very pleased to hear that for the first time in many years there is a significant projected increase relative to inflation in R&A funding, in addition to the

already significant projected increase in DA. We emphasize that in order for these projected increases to be effective, it is essential that R&A and DA funds not be used to solve problems in the flight programs, as has happened in the past in some themes. We also reiterate a key point that we have made previously. In order for all themes to benefit from the substantial projected growth in peer-reviewed science funding***, some themes must work harder to expand the scope and accessibility of their Data Analysis programs.*** This need seems particularly acute for Solar System Exploration.

Guenter raised the issue of R&A and DA award sizes, and presented several possible strategies for raising the average award size, which has not kept pace with inflation. Although we shared his concern about this issue, we feel that the guiding principle governing decisions on award size should be the goal of achieving the most science per dollar within a given discipline. Toward this end, ***we encourage Guenter to remind review panels and the community that in some instances science can be maximized by including a small number of grants that are significantly larger than average***.

Guenter also asked us to consider whether or not a process should be put in place to assess whether Code S has achieved the appropriate balance among R&A, DA, and flight projects. An overemphasis on flight projects, to the detriment of combined R&A plus DA, has been a concern of the science community in the past. However, the projected future trends in R&A plus DA growth are very positive, and directly address community concerns. Given this projected growth, ***we do not see a need for a review process at this time***. Projected growth must become real growth, however, so we will revisit this question again a year from now.

GPRA 2000 Performance Report

As part of our annual responsibilities under the Government Performance and Results Act (GPRA), we reviewed Code S's F.Y. 2000 Performance Report. Performance overall has been excellent, with "green" scores awarded to the vast majority of the targets. A detailed report of our evaluation is in preparation, and will be presented to the NASA Advisory Council at its next meeting.

Education and Public Outreach

Finally, we heard an invigorating presentation on Code S's Education and Public Outreach programs from Jeff Rosendhal, Isabel Hawkins, and others. These programs are among Code S's great successes of the past several years, and we continue to be impressed with their breadth and impact.

That summarizes the results of our meeting. Please don't hesitate to contact me if you would like any clarification or further detail on any of the points that we've raised above.

Best wishes,

Steve Squyres
Chair, SScAC

cc: SScAC
B. Parkinson
L. Garver
M. Allen
J. Rosendhal
K. Olsen
S. Hubbard
G. Riegler
J. Alexander
C. Beichman

SPACE SCIENCE ADVISORY COMMITTEE (SScAC)
Jet Propulsion Laboratory, Pasadena, CA
November 1-3, 2000

LIST OF PRESENTATION MATERIAL[1]

1) Advanced Rover Development [Baumgartner]
2) Structure and Evolution of the Universe – Theme Director's Remarks [Bunner]
3) Solar System Exploration [Bergstralh]
4) The Mars Program: 2005 and Beyond [Hubbard]
5) State of the Theme – Origins [Kinney]
6) NASA's Fifth Strategic Enterprise – Office of Biological and Physical Research [Olsen]
7) The Sun-Earth Connection Advisory Subcommittee Report [Walker]
8) FY00 Progress on Science Objectives [Allen]
9) Outer Solar System Restructuring [Bergstralh]
10) Space Science Enterprise [Weiler]
11) SEUS report to SScAC [Margon]
12) Solar System Exploration [Drake]
13) Research and Analysis and Data Analysis Programs [Riegler]
14) Space Science Education and Public Outreach: Some Recent Highlights [Rosendhal]
15) Origins Subcommittee [Dressler]
16) SEC Theme Status [Spann]

Other material distributed at the meeting:

1) Education/Public Support Network
2) Space Science Resource Directory
3) SSB [brochure]
4) SSB Reports published in 2000, reports in development, projects under consideration
5) Space Studies Bulletin
6) Mars Mission Timeline
7) The Space Place [information folder]

[1] Presentation and other material distributed at the meeting are on file at NASA Headquarters, Code S, Washington, DC 20546.